

# EFFECTS OF DISLOCATIONS IN STRANSKI-KRASTANOW QUANTUM DOTS.

Rosa Leon

Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA

The interrelations between structural and optical properties in Stranski-Krastanow (S-K) quantum dots are examined through different experiments that explore III-V quantum dots (QD) formation. First, the evolution of ternary InGaAs QDs using a positionally varying growth rate will be described. Island densities were seen to increase exponentially before saturation. Photoluminescence (PL) of capped structures showed that wetting layer (WL) PL energies did not shift beyond the onset of the S-K transition. After saturation, a sharp drop in PL intensity was observed, which was attributed to island coalescence and incoherent island formation.

In a multilayered InGaAs/GaAs quantum-dot (QD) structure, a transition between two types of step alignment, and a change to larger QD sizes in smaller concentrations was observed after formation of a dislocation array. Cathodoluminescence (CL) spectra showed a bimodal peak with lower energy peak enhancement when probing at lower e-beam energies. CL imaging and cross-sectional transmission electron microscopy showed contrast from a dislocation array formed at the interface between GaAs and the first InGaAs QD layer. Strong QD emission in the near infrared (800 to 1100 nm) was obtained despite the presence of dislocations.

Highly ordered patterns of InAs QDs were obtained on InGaAs dislocation arrays, where rectangular patterns of misfit dislocations are transferred into well-separated rows of sharply aligned InAs quantum dots. Since dislocations may act as nonradiative recombination centers and reduce QD carrier lifetimes, their optical properties were compared with those of standard InAs QD structures. The most striking difference observed was in the dependence of the PL intensity on photoexcitation power. Without dislocations, the PL intensity increases linearly with excitation intensity, indicating that efficiency of carrier transfer from the barriers into the dots is not carrier-density dependent. On the other hand, dependence of the QD-PL intensity on excitation intensity exhibits a strongly superlinear behavior in the ordered QD samples. This effect is attributed to carrier trapping at the dislocation layer, which reduces the number of carriers reaching the QDs.